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June 26,1986

Arapaho National Wildlife Refuge
Midland - McFarlane Ditch
HEC-2 Calculations and Notes

The attached HEC-2 runs are based upon the field survey data obtained on June 5, 1986. First, the observed water surface elevations and discharges were used to calibrate HEC-2 and obtain estimates of Manning's "n" for each cross section. These "n" values were then used in subsequent runs to determine the water surface profiles for three discharges: 40 cfs, 45 cfs, and 50 cfs. The high-water mark was measured approximately 27 feet upstream of the headgate (at cross section 4 of the survey notes, cross section 9 of the HEC-2 runs). This high-water mark is reached at a discharge of 45 cfs, when the computed water surface elevation of 98.47 feet at cross section 9 of the HEC-2 run is within one-tenth foot of the measured high-water mark of 98.39 feet at cross section 4 of the survey notes.

Note that cross sections 10, 11, and 12 are extended (vertically) in the HEC-2 runs for 45 cfs and 50 cfs. This indicates that some flow is lost over the right (looking downstream) bank at these flows although these losses are not accounted for in these runs. Thus, to obtain the head required to match the estimated high-water mark and pass 45 cfs through the culvert, a slightly larger inflow above the measured reach would be required. Downstream of the culvert, cross sections 2, 3, 4, and 5 have been extended on the left bank. These extensions are based on prevailing ground slope measurements at the 0.0 station for the four cross sections.

I also ran HEC-2 using the measured channel and pipe dimensions and slopes and substituted Manning's "n" values of 0.035 for the ditch channel (except at cross section 2 where n = 0.100 is retained), 0.050 for the overbank area and 0.025 for the pipe. These conditions result in a computed water surface elevation of 98.37 feet at cross section 9 of the HEC-2 run.

The Division Hydrographer for the State of Colorado Division of Water Resources measured discharge in the McFarlane ditch on May 2, 1986 and May 9, 1986. On May 2, he measured approximately 24 cfs in the ditch with an effective depth upstream of the culvert of 1.8 feet. This corresponds to an upstream water surface elevation of 97.45 feet using our

datum and compares favorably to the measured water surface elevation of 97.55 feet on June 5 when discharge in the McFarlane ditch was again measured at 24 cfs. On May 9, the discharge was measured at 44 cfs with an effective depth of 2.35 feet at the upstream side of the culvert. This corresponds to an upstream water surface elevation of 98.00 feet using our datum and compares favorably to the estimated water surface elevation of 97.89 feet at cross section 8 of the HEC-2 run for 45 cfs.